REMARKS

Original Claims 1-56 were pending in the subject application, including five independent Claims 1, 39, and 54-56. After entry of the amendment set forth above, which does not change any claim number or dependency, Claims 1-56 are pending, including independent Claims 1, 39, and 54-56.

Amendments to the Claims

No new matter is added by the present amendments, which are explained in more detail below. Claims 1-2, 4, 7, 10, 13-14, 21, 24, 27, 32, 39-42, 48, 50 and 54-56 are amended herein. These amendments are supported by the claims as originally filed. The amendments merely clarify antecedent bases, or correct typographical errors, except that Claim 13 is slightly broadened by removal of a mathematical definition corresponding to the verbal recitation of the claim. No claim is narrowed by the present amendment.

Objections to the Drawings

In section 1 of the current Office Action, the Examiner objects to Figures 1, 2 and 3 as requiring a designation as "Prior Art." These figures are amended accordingly herein.

In section 2 of the current Office Action, the Examiner objects to the drawings under 37CFR 1.83(a), specifically stating that variables "$\mathbf{w}_{test1}$," "$\mathbf{w}_{test2}$," "$\mathbf{a}$," "α_k," "$\mathbf{w}_{base1}$," "$\mathbf{w}_{base21}$," "$\mathbf{A}$," "$\mathbf{p}_1$," "$\mathbf{p}_2$," "$\mathbf{C}$," "$\mathbf{I}$," "$\mathbf{F}$," "**D**" and "**E**" (collectively, "the challenged symbols") must be shown in the figures or canceled from the claims. Amendment of the drawings in response to this objection would be counterproductive, for the reasons set forth below.

These challenged symbols are not "features," and as such 37 CFR 1.83(a) does not apply. The features of the claim, which may include manipulation of concepts represented by variables, are thoroughly disclosed in the drawings. To indicate manipulations of concepts according to equations, it is necessary to represent such concepts as unitary symbols (*e.g.*, a unitary word, typically not in a spoken language, consisting of some combination of letters and other symbols not separated by blank spaces). Such symbols may be variable symbols or simply representative symbols.

Accordingly, each concept of a claim (such as, for example, a particular "weight vector"), upon which operations to be performed need (for reasons of precision and clarity) to be indicated by means of an equation, must be provided with a symbol to represent such concept within the equation. The symbols employed for this purpose need to be consistent within the confines of the claim (including all claims upon which a

particular claim depends). However, it will often be advantageous to use a unique symbol for such a concept within a claim. A unique symbol will reduce a risk of importation of contextual meaning that may be appropriate in the specification, but is unintended as a limitation in a claim. Some symbols are indicated as related, yet distinct, by use of a common symbol with a distinct subscript.

Representation of concepts by symbols in order to show relationships within equations is entirely proper. This practice enhances, rather than reduces, the clarity of the claim, presuming of course that the concept represented by the symbol is properly defined, such as within the specification or within the claim. Such definition is properly provided in the instant situation. As the mathematical symbols in the claims are not "features" but merely common mathematical "words," the objection to the drawings on this grounds is unwarranted. The explanation set forth below in response to corresponding rejections of the claims for lack of enablement will further clarify this issue.

Rejections Under 35 USC 112

In section 3 of the current Office Action, the Examiner rejects Claims 1-38, 40-43, 48-51, 54 and 55 as not being enabled, because the variables "w_{test1}," "w_{test2}," "a," "a_k," "w_{base1}," "w_{base21}," "A," "p_1," "p_2," "C," "I," "F," "D" and "E" ("the challenged symbols") do not appear in the specification. This grounds for rejection of claims corresponds to the objection to the drawings that is discussed immediately above.

The terms objected to the Examiner are all mathematical symbols that have been assigned to particular concepts represented within a claim in order to permit precise indication of relationships between the concepts by the use of equations. It is respectfully submitted that each and every symbol utilized throughout the presently pending claims will be readily and properly understood by the person of skill in the art. The present invention can best be described and understood in mathematical terms that are sometimes arcane. This is an advanced field, and the level of skill in the art is very high. The skilled person in this field has an extensive understanding of mathematical concepts and conventions.

While a patent application need not enable a person unfamiliar with the field to make and use the invention, it is desired that the Examiner should properly understand the scope of the claimed invention. To that end, some explanation of the challenged symbols is set forth below. Indeed, careful consideration of the explanations set forth below will help to make clear the distinctions that are subsequently drawn over the cited prior art.

Claim 1 recites in part "a first test weight vector, w_{test1}, comprised of one complex element for each antenna of the transmitting unit." Thus, the definition of the concept represented by the variable w_{test1} is clearly set forth within the recitation of the claim itself. Test weight vectors are shown and discussed throughout the Applicant's specification, including, for example, in FIGURE 4 and the associated text, in particular with regard to the inputs to blocks 68 and 70, and in FIGURE 7, and the associated text, from page 18 line 23 to page 19 line 8, with respect to block 104.

w_{test2} is similarly described in Claim 1, and is given a different subscript, as explained above, in order to distinguish it from the related but distinct variable w_{test1}. In Claim 3 these two concepts are claimed in a relationship defined by an equation, for which reason they need to be unitary symbols, or variables. Note that if a concept is provided with a symbolic representation that is not then entered into an equation, there is no loss of clarity or accuracy. Indeed, providing a symbolic representation for a concept in a claim may help to clarify that the concept is of a sort that may be quantitatively manipulated in an equation.

The symbols "**a**" and "a_k" are part of a mathematical expression that is provided in Claim 4 to precisely define "2-norm." "**a**" represents any vector, and the double bars are a standard indication of the norm of the expression within such double bars. Merriam Webster's Online Dictionary (at www.m-w.com/cgi-bin/dictionary?book=Dictionary&va=norm&x=16&y=15) provides the following definition of "norm:"

> **4 a :** a real-valued nonnegative function defined on a vector space and satisfying the conditions that the function is zero if and only if the vector is zero, the function of the product of a scalar and a vector is equal to the product of the absolute value of the scalar and the function of the vector, and the function of the sum of two vectors is less than or equal to the sum of the functions of the two vectors; *specifically* : the square root of the sum of the squares of the absolute values of the elements of a matrix or of the components of a vector.

Thus, the expression in Claim 4 provides a summation of the k-indexed components a_k after squaring their magnitude, as is consistent with the definition set forth above. The normalization of the vectors is a mathematical operation that is performed, for example, in block 104 of FIGURE 7, as described on page 19 at lines 9-12. (This is a continuation of the description of block 104 that begins on the last line of page 18.)

The variable "*A*" is defined within Claim 6 as "scaling factor *A*." A scaling factor indicates a proportionality between the left and right sides of an equation, without improperly indicating an equality. This mathematical technique is very well known to the skilled person, and requires no further explanation. In a single equation, the scaling factor could be replaced if the equality was replaced by a symbol for proportionality; however, the scaling factor *A* in Claim 6 conveys a further relationship between the two weight vectors, namely that they have the same proportion to their respective perturbation unit vectors.

The variables $\mathbf{p}_1$ and $\mathbf{p}_2$ are defined in Claim 6, for example, as perturbation vectors. Their relationship to the test weight vectors is clearly indicated by equations, for which they (or alternative symbols) are required. Perturbation vectors are extensively discussed in the Applicant's specification, for example in block 102 of FIGURE 7 and in the accompanying text beginning on page 18, line 6 and extending to page 19 line 7. The symbol used to represent such perturbation vectors (*e.g.*, $\mathbf{p}_1$) must be different than the symbols used for perturbation vectors in the specification in order to avoid an improper construction that would place limitations upon these variables based upon description. The perturbation vector symbol in Claim 6 is more general than, for example, either β or $\mathbf{v}$, as well as the product of those variables, which are discussed in the specification. The perturbation vector symbol in Claim 6 must be very general, such that further limitations can be placed thereupon in dependent claims, such as in each of Claims 7-15.

Claim 15 employs the variable C, which is defined by "the scalar *C* determines the amplitude of the vector." In this case, the variable *C* permits definition of $\mathbf{v}$ in a manner that does not fix the magnitude of $\mathbf{v}$. The definition is very precise, though it has a wide range of latitude in magnitude.

In Claim 13 the mathematical expression unnecessarily limited the linguistic recitation, and, as such, the mathematical expression has been deleted from the claim. The variables D, E and F are each scalar scaling factors, as recited in Claims 32, 33 and 25, respectively. They are different to avoid confusion. Their use constitutes standard mathematical practice, and enhances the clarity of the claims for the skilled person.

Thus, each of the challenged symbols is properly used in a claim in order to indicate relationships with mathematical precision. It is respectfully submitted that all are used correctly, and that the skilled person will understand their use perfectly. The challenged symbols are commonly understood in the language of mathematics, and are entirely proper for use within claims, in the same way that commonly understood words need not be present in the text of a specification in order to be properly used in claims. Accordingly, the Examiner is respectfully requested to withdraw this grounds for rejection of the various claims noted above under 35 USC 112.

Rejections Under 35 USC 102

In section 4 of the current Office Action, the Examiner rejects Claims 1-56 as anticipated by U.S. Patent 6,434,366 to Harrison, et al. ("Harrison"). This grounds for rejection is respectfully traversed. As will be explained below in detail, Harrison fails to teach all of the elements recited in any one of the present independent claims, Claims 1, 39, and 54-56 (both as originally filed and as presently amended), and accordingly fails to anticipate any of these claims. The remaining claims pending in the subject application each properly depend from one of these independent claims. Accordingly, Harrison fails to anticipate any pending claim. To understand the failure of Harrison to teach, disclose or fairly suggest all of the limitations recited in any pending independent Claim, it will be helpful to contrast the teaching of Harrison with the teaching of the Applicant, before turning to the explicit recitations of the pending claims.

General Considerations of Harrison

Harrison teaches a method for estimating adaptive array weights. The abstract of Harrison states that (after transmitting a communication signal together with an element pilot signal coupled to one of the antenna array elements) "Thereafter, the adaptive array weights used at the transmitter are estimated in response to comparing characteristics of the received element pilot signal to characteristics of the received communication signal." Such estimation must be performed by the receiver (the subscriber unit, in Harrison), as may be seen, for example, in block 104 of FIG. 1 of Harrison.

The primary approach of Harrison, as noted above, requires the mobile station ("MS" or "mobile" in the subject application, "subscriber unit" in Harrison) to perform channel estimation. This approach differs fundamentally from that taken by the Applicant, which does not require the MS to perform channel estimation. Indeed, the background section of the subject application explains the problems with the approach taken by Harrison, including difficulties with misleading quantization error in the estimates, and a need to estimate the channel from each of the plurality of transmitter antennae individually (see all of pages 2 and 3 of the Applicant's specification). The background of the Applicant's specification notes succinctly (page 2, lines 8-10): "The difficulty here is that the MS can measure the channel, but it is the BS which needs this information to adjust its transmit weights."

For purposes of understanding the context of the claims, the preferred approach taught by the Applicant may be contrasted with that taught by Harrison. The preferred embodiment (not to be confused with the claimed invention) of the Applicant does not require the MS to estimate the channel. Rather, the BS

"tries" different weights, and simply asks the MS to determine which weight is better by comparing signal strength under different weightings.

Note that in the Applicant's preferred embodiment (again, not to be confused with the claimed invention) the receiver need only indicate a choice between two items. Such a binary choice may be indicated with a single digital "bit" of information. This contrasts with the much larger quantities of bits that are needed to provide feedback according to the teaching of Harrison, as discussed subsequently in more detail.

Harrison teaches that the subscriber unit estimates the channels (see, *e.g.*, col. 3 lines 53-65); after estimating the channels, the subscriber unit transmits control data to the transmitter to control the weights to be used (see, *e.g.*, col. 3 line 66-col. 4 line 5). At this point, Harrison teaches several techniques conveying the desired weights back to the BS: 1) send recommended phase and gain directly (col. 4 lines 5-8); 2) send a reference to a "code book" of such weights, known to both MS and BS (col. 4 lines 9-16); or 3) send quantized channel impulse response estimates (col. 4 lines 17-20). These various approaches all require the MS to estimate the channels, and to either feed the estimates to the BS, or else to directly indicate to the BS a desired weighting in view of those estimates. Such requirements to estimate channels at the MS are fundamentally different from the teaching of the Applicant, as noted above.

However, Harrison also suggests one other method: 4) "[T]he transmitter control data may be an error rate indication which provides feedback to the base transceiver regarding the effectiveness of a recent selection of weights." (col. 4 lines 20-23, see also col. 6 lines 55-60). This alternative is specifically noted because it is different from all of the other techniques taught by Harrison, in that it does not necessarily require the MS to estimate the channels. This alternative differs in important regards from the approach taken by the Applicant, but does not share all of the fundamental differences noted above for Harrison's primary approach. However, few details of this approach are set forth in Harrison, and the details provided (such as the use of error rate as a measure of weight "goodness") differ substantially from the teaching of the Applicant. Nonetheless, this approach is especially noteworthy, if only because the primary approaches that are elaborated in Harrison contrast even more fundamentally with the approach described by the Applicant.

Claim Elements Not Taught By Harrison

The foregoing is not to be construed as in any way limiting the claims, but rather provides context to aid in understanding how and why Harrison fails to teach, disclose or fairly suggest all of the elements (or

combinations) that are recited in any of the presently pending independent Claims 1, 39, and 54-56. Each pending independent claim will be discussed in turn.

Independent Claim 1, as presently amended, recites in part:

> (c) during a first time period ... [applying] a first test weight vector ... ; ...
>
> (e) during a second time period that does not overlap with the first time period ... [applying] a second test weight vector ... different from the first ... ; ...
>
> (g) generating a new weight vector, w_{new}, ... [that] is a function of the first and second weight vectors.

Harrison fails to disclose this combination, particularly clause (g). That is because the approach of Harrison primarily involves calculating weight vectors based upon channel estimates. The channel estimates are performed at the MS. New weight vectors may be calculated at the MS or at the BS, but such weight vectors are based, directly or indirectly, upon channel estimates. There is no teaching, disclosure, or fair suggestion in Harrison that a new weight vector should be a function of previous weight vectors from distinct time periods, as required by Claim 1 (both as originally filed and as presently amended). Thus, Harrison fails to anticipate Claim 1.

Independent Claim 39, as presently amended, recites in part:

> in each of the plurality of transmitting units, performing the following steps:
>
> (c) during a first time period, adjusting ... according to ... a first complex number; ...
>
> (e) during a second time period ... , adjusting to ... a second complex number, that is different ...; ...
>
> (g) generating a third complex number ... [that] is a function of the first and second complex numbers.

Claim 39 describes a different method from Claim 1, in which some different antennas may be associated with entirely different transmitters. The terminology differs accordingly. For example, complex numbers are recited, rather than weight vectors, due to their application to as few as one antenna at a time. Nonetheless, the elements noted above are similar enough to those described above with respect to Claim 1 to

recognize that Harrison fails to teach this combination for at least similar reasons as are set forth with regard to Claim 1. As noted there, Harrison bases his calculations of weights (or complex numbers) on channel estimates, not on previous weights as required by Claim 39. Harrison accordingly fails to anticipate independent Claim 39 (both as originally filed and as presently amended).

In regard to Claim 54 (both as originally filed and as presently amended), clause (c) requires first and second weight vectors, and clause (e) requires a new weight vector that is a function of the first and second weight vectors. For reasons similar to those set forth above with respect to Claims 1 and 39, Harrison fails to teach, disclose or fairly suggest such a combination. Moreover, Claim 54 further requires "[A] receiving unit ... can determine whether the first weight vector or the second weight vector results in a stronger signal." Harrison has no relevant teaching, disclosure or suggestion to this effect. As such, Harrison fails to anticipate Claim 54 for the reasons set forth in this paragraph, over and above the reasons set forth above with respect to Claims 1 and 39.

In regard to Claim 55 (both as originally filed and as presently amended), clauses (c) and (d) are not taught, disclosed or suggested by Harrison. Harrison calculates weights based upon channel estimates, and does not use power measurements to evaluate weight vectors. The closest that Harrison comes to these limitations is a bare suggestion of using error rates to evaluate recent weight vectors. There is no teaching of what to do with such evaluation, and, moreover, power measurements are quite different from error rates. Thus, Harrison fails to disclose, teach or suggest all of the required elements, and thus fails to anticipate, Claim 55.

Analysis of the failure of Harrison to disclose all of the features of Claim 56 (both as originally filed and as presently amended) is particularly interesting, because the failure underscores a significant advantage of the Applicant's approach, also noted above, that (in some embodiments) a single bit of feedback information may suffice. Harrison cannot rely upon single bit feedback, as explained more fully below.

Harrison fails to teach, disclose or suggest several features of Claim 56, and particularly clauses (e) and (f): "(e) receiving a single information bit of feedback from the receiving unit; (h) adjusting the ... signals based upon the value of the single information bit." Claim 56 recites a feature that addresses one of the problems with prior art approaches, such as Harrison, namely the need to communicate, to the BS, the information that is sensed by the MS. Even Harrison notes that communicating weights between units may absorb too much of the available bandwidth, stating "In a system that rapidly changes weights, the overhead of sending so many messages reduces system capacity for transmitting user traffic." (col. 2 lines 21-23) This

statement of Harrison regards communicating weights to the MS. Harrison does not dwell upon the problem of communicating weights to the BS, although the suggestion of a "code book" for communicating such information seems to represent an effort by Harrison to mitigate this overhead problem.

Harrison not only fails to teach the features required by clauses (e) and (f), but, moreover, none of the approaches identified by Harrison is even capable of directing adjustment of the signals based upon a single bit of information, as required in Claim 56. Harrison suggests sending, from the MS to the BS, either weights, channel estimates, a code book entry, or information about error rates. None of these may be reasonably conveyed with a single bit of information. The preferred embodiment of the Applicant, however, accomplishes single-bit feedback quite handily, thus supporting Claim 56. A single bit of information is sufficient to choose between the results of a first weighting compared to the results of a second test weighting. Such comparison could be based upon a variety of metrics, including for example error rate (as suggested in Harrison), or power (as preferred). In the preferred embodiment, the MS need only know how to distinguish the two test weights (they may be disposed in different orthogonal code spaces, for example, or in different time slots), and then report a single bit back to the BS indicating which of the two test weights is preferred.

Thus, the failures of Harrison to disclose the features required by Claim 56, some of which are set forth above, provides a stark contrast between Harrison and the teaching of the Applicant. This contrast underscores fundamental distinctions between the approaches taken by Harrison and the Applicant, thus providing a further basis for understanding how and why Harrison fails to disclose all of the elements required by any of the other pending independent claims (as is noted above with regard to each independent claim).

It is respectfully submitted that these remarks, together with the other remarks set forth above in this section addressing the rejection under 35 USC 102, amply demonstrate the failures of Harrison to anticipate any of the independent claims. As such, Harrison also fails to anticipate any other pending claim, each of which depends from one of the unanticipated independent claims. Accordingly, the Examiner is respectfully requested to withdraw this grounds of rejection.

Conclusion

In view of the foregoing remarks and amendments, it is respectfully submitted that each claim, as presently pending in the subject application, is in condition for immediate allowance. As such, the Examiner is respectfully requested to withdraw each of his grounds for rejection, and to promptly issue a Notice of Allowance in respect of all pending claims.

It is particularly noted that, as set forth above in detail, none of the claims have been narrowed to overcome any of the grounds for rejection set forth in the current Office Action. Accordingly, should the Examiner find new grounds for rejecting any pending claims, a further non-final Office Action setting forth such new grounds is respectfully requested.

The Commissioner is authorized to construe this paper as including a petition to extend the period for response by the number of months necessary to make this paper timely filed. Fees or deficiencies required to cause the response to be complete and timely filed may be charged, and any overpayments should be credited, to our Deposit Account No. **50-0490**.

Respectfully submitted,

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